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A physical basis of the Tully-Fisher relation.

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Publication date:
1996

locity fields. The explanation for this difference is related to the different ways the one- and two-dimensional optical and H I rotation curves are derived. The one-dimensional optical rotation curves represent the rotation velocities measured along a slit aligned with the major axis, assuming inclinations based on optically determined axial ratios. In this respect they are derived in a similar fashion as the rotation curves of the galaxies in XV-Sample (Sect. 8.3).

In summary, obtaining rotation velocities from one-dimensional observations along the major axes of galaxies, either optically (Rubin et al. 1985, Mathewson et al. 1992) or in the radio wavelength regime (as described here, see Sect. 8.5), does not decrease the scatter in the TF relation significantly. It is also noted that the use of the random-motion corrected linewidths by using equation 2 with any of the random-motion parameters used in this paper, always fails to reproduce the slopes of the '$V_{\rm flat}$' or '$V_{\rm max}$' TF relations.

8.6 Summary and Conclusions

In the first part of this paper we have shown that it is possible to derive first-order rotation curves from the XV-maps. The main uncertainty in the derivation of these curves is the run of inclination angle with radius, since only information along one spatial direction is available. From each rotation curve a so-called representative rotation velocity is determined, which defines the 'best' estimate of the rotation velocity of a system.

A rotation velocity was also determined from the width of the global HI profile. This can be done, provided that corrections are applied for random gas motions. From the comparison of the global profile widths and the rotation velocities, obtained from kinematical fits to two-dimensional velocity fields for a sample of 28 galaxies (RC-Sample), we found that the most-frequently used random-motion correction formulae (TFq) are not very satisfactory. For a large sample of galaxies the rotation velocity parameter ($W_{\rm R}^{\rm i}$), derived with these corrections, may be statistically equal to the true rotation velocity, but in individual cases the differences can be large, since one of the parameters in these correction formulae, the correction term for random gas motions $W_{{\rm t},l}$, varies considerably from galaxy to galaxy. In Sect. 8.4, we describe the analysis of a sample of 28 galaxies with well-determined HI rotation curves to find the values of $W_{\rm t}$ at the 20% and the 50% intensity level. We find that there is not only a large spread in the value of $W_{\rm t}$, but it also depends on the way the rotation velocity of a galaxy is defined: by the 'true' maximum rotation velocity or by the velocity of the flat part of the rotation curve. If the first definition is chosen, then $W_{\rm t,20} = 20 \pm 16$ km s^{-1} and $W_{\rm t,50} = 8 \pm 12$ km s^{-1}; with the second definition the values are $W_{\rm t,20} = 30 \pm 24$ km s^{-1} and $W_{\rm t,50} = 18 \pm 19$ km s^{-1} (mean and standard deviation from the mean). In any case these values are much smaller than the ones derived by FBGP, but still comparable with the values used by BGPV (i.e. $W_{\rm t,20} = 38$ km s^{-1} and $W_{\rm t,50} = 14$ km s^{-1}).

In the last part of this paper the TF relations for RC- and XV-Samples are analysed. Recently, it has become clear that the scatter in this relation can be reduced considerably by using rotation velocities from velocity fields instead of velocities derived from global HI profile widths (e.g. Schommer et al. 1993). We found a similar effect for the sample of galaxies with accurate HI rotation curves mentioned above (RC-Sample), and this motivated us to investigate whether we could also achieve a reduction in the dispersion in the TF relation of XV-Sample by using the representative velocities ($V_{\rm RC}$), determined directly from the 'one-dimensional' rotation curves. Unfortunately, this was not the case; the differences between the TF relations using $W_{\rm R}$ and $W_{\rm RC}$ are small. Apparently, the improvement in the accuracy of the velocity parameter in the TF relation is related to the use of two-dimensional velocity information, which allows one to determine the inclination of a galaxy kinematically. From the work by, amongst others, Rubin et al. (1985) and the study described here, we conclude that the derivation of rotation velocities from one-dimensional observations along major axes of galaxies (either with optical or radio telescopes), using inclinations derived from optical axis ratios, does not reduce the scatter in the TF relation.

8.7 References

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